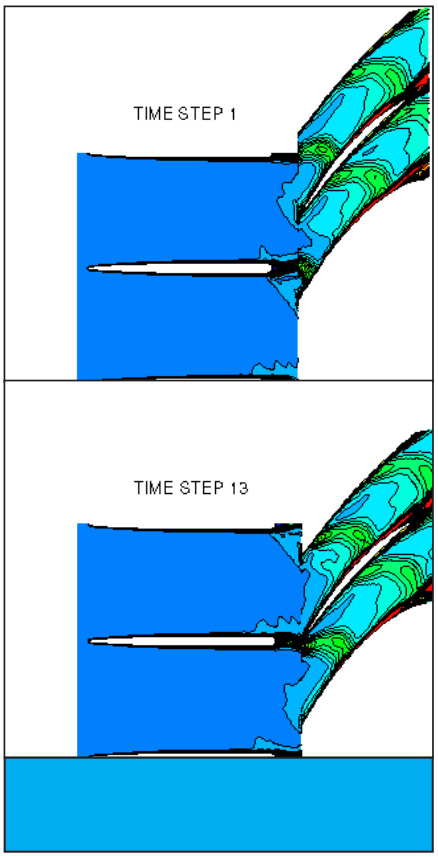
Air Force Research Laboratory | AFRL
Science and Technology for Tomorrow's Aerospace Forces

Success Story

ADVANCED COMPRESSOR DESIGN BENEFITS FROM FIRST DEMONSTRATION OF NEW MODELING AND SIMULATION CODE



The Propulsion Directorate's Turbine Engine Division is making significant advancements in the modeling and simulation of unsteady flows for advanced turbine engine compressors. This new, in-house capability enhances the directorate's ability to deal with the complex and challenging flows associated with high-performance compressor designs. This capability will help directorate engineers achieve the goal of the Integrated High Performance Turbine Engine Technology (IHPTET) program to double the propulsion capability of turbine engines by 2005.

Air Force Research Laboratory
Wright-Patterson AFB OH

Accomplishment

The directorate's Compressor Research Group successfully applied an unsteady three-dimensional Navier-Stokes computational fluid dynamics code to model a research compressor. This is the first in-house demonstration of this advanced code. The code, called MSU TURBO, is a three-dimensional, viscous, time-accurate code that solves the Reynolds Averaged Navier-Stokes equations in Cartesian coordinates in a rotating frame of reference. Directorate scientists are using the code to model the stage matching investigation (SMI) rig recently tested in the directorate's Compressor Aero Research Lab.

Experimental data from the SMI rig test shows that axial blade-row spacing affects the rotor efficiency and pressure ratio. Directorate engineers use MSU TURBO to model the unsteady interaction between the stator and the transonic rotor in an effort to understand the flow physics driving the change in compressor performance with axial blade-row spacing. The code ran on a Cray supercomputer at the Naval Oceanographic Office Major Shared Resource Center and took 225 hours of central processing unit time to reach a converged solution.

Background

IHPTET is a national program coordinating the efforts of the Air Force, Army, Navy, National Aeronautics and Space Administration, and major US gas turbine engine manufacturers. To meet IHPTET goals and the follow-on program's (Versatile Affordable Advanced Turbine Engines) goals, directorate engineers are designing fans and compressors with increased stage loading and closer axial blade-row spacing.

The understanding of unsteady blade-row interactions has a significant impact on performance attainment and prevents high-cycle fatigue failures. Accurate analysis of these complex fields is imperative to understand the flow physics of these compressors in order to design the high-performance and durable compression systems for advanced turbine engines.

Propulsion
Emerging Technologies

Additional information

To receive more information about this or other activities in the Air Force Research Laboratory, contact TECH CONNECT, AFRL/XPTT, (800) 203-6451 and you will be directed to the appropriate laboratory expert. (01-PR-04)